

Science Education for a Minority Within a Minority

Rosa M. Bradley

COMPARATIVELY little has been reported concerning the reasons for the scarcity of Black female scientists, mathematicians and engineers (Clewell & Anderson 1991). White male domination of these fields may be one critical reason for the dearth of Black female career scientists. Historically, women, regardless of race or qualifications, have been unwelcomed and actively discouraged from pursuing careers in these disciplines (Rossiter 1982).

For Blacks, many of the obstacles to their pursuit of careers in science, mathematics and engineering (the quantitative disciplines) are rooted in the history of Blacks in America. During slavery (1641–1863), it was illegal to educate Blacks in the United States (Franklin 1976). People of African descent were considered to be innately inferior and uneducable. After the Civil War, during the short period of the Reconstruction governments, Black children were able to receive formal education. When the Reconstruction governments were overthrown, the schools were segregated by race, and those assigned to Blacks were not only separate, but decidedly unequal. The stigma of inequality remained.

Since the end of slavery, Blacks have had to overcome both the stigma and the self-image of inferior intelligence and capability. This stigma, still perpetuated in many subtle (and not so subtle) ways, does little to inspire young Black children to pursue the quantitative disciplines. Rather, they are steered to traditional areas of study, those considered “open” to Blacks. Science has never been and still is not one of these fields. As a result, there are comparatively few professional Black scientists. For example, in 1993, African-Americans received only 6.3% of the bachelor’s degrees, 3.1% of the masters degrees, and only 1.9% of the doctoral degrees awarded in the quantitative sciences (National Science Foundation 1995). Therefore, for the majority of Black children, Black scientists as role models are practically nonexistent. Now, however, as school curricula are revised, the contributions of Black scientists are beginning to be recognized (Hacker 1992).

Couple this historical background with the racist and sexist attitudes pervading society and impacting on the educational system, particularly in Black and minority areas (McBay 1992; Hacker 1992), and it becomes evident that for too many Black females, these barriers are often insurmountable. Therefore, too few African-American females are prepared to choose careers in science.

This paper is based on the premise that the entire educational system needs reassessment—from pre-school years to college—if there is to be an influx of women, particularly African-American women, in the quantitative sciences. The following discussion provides strategies, focusing on science education, that are based on a search of the literature, and on my personal experience as a biology teacher.

Early Childhood

Head Start, created in 1964 under the Economic Opportunity Act, provides comprehensive developmental services for low-income, pre-school children. As the program grew, its success became apparent, and now it is recognized nationally as an effective educational model for young children and their families. Proposals have been made to expand the program to include all eligible children and to make it even more effective (Shanker 1993; Watson 1992). These formative years have been shown to be the most critical in furthering the learning capabilities and stimulating the interests of children. Therefore, reading, writing, language, mathematics and computer skills must be incorporated into the pre-school curriculum. Hale-Benson (1986) also emphasizes the need for pre-school Black children to develop a love of learning, a positive self-image, and knowledge of, and appreciation for, African and African-American history and culture.

Elementary School

1. Young children, because of their natural curiosity and enthusiasm, can learn the basic concepts of mathematics and science if they are stimulated to do so. Having received early exposure, they should be less predisposed to avoid these subjects in their later school years. According to Dr. Daniel C. Davis, Director of the Minority Engineering Program at Penn State:

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"Good, sound preparation in math, algebra, and trigonometry is lacking" for most minority students. He points out that "the poor quality of elementary and secondary education that many Black and Hispanic students receive has been identified as a critical factor limiting their access to and success in higher education" (Black Issues 1986a).

Research shows (Clewell & Anderson 1991) that African-American girls, in general, like science and mathematics in the elementary and early high school years, but thereafter, develop increasingly more negative attitudes. Similar results have been reported in other studies (United States Department of Education 1993; Black Issues 1986b).

2. For many African-American children in the inner cities, school should be a haven from the dangers in the streets. Children would look forward to school if they were exposed to a wide variety of educational challenges and pursuits in a nurturing and supportive learning environment. The classroom must be an environment in which children develop the joy of learning and are encouraged to work hard. They must be in a milieu within which their "daydreams" of careers in mathematics or science, or in any other area, are encouraged and are brought closer to reality by teachers who care about them.

3. Black children need knowledgeable, well-trained, caring teachers who demand excellence of themselves and their students. Teachers like these will be able to provide the proper learning environment in the classroom. Black students also need more teachers like themselves as role models in the classroom to instill hope and to raise their aspirations. This is not to say that White teachers cannot, and have not, been role models for African-American children.

4. Parents have a crucial role to play, if more African-American females are to enter scientific fields. In order to ensure a quality general education and science and mathematics background, parents must be actively engaged in the education of their children in school and in the home. They must expose their children, particularly the girls, to science and mathematics projects, and other educational opportunities, including science fairs, local library programs, trips to the zoo, to museums and special programs at local schools and colleges. Parents can make television a potent educational tool if they carefully select programs and interact with their children concerning their content. Local churches and community organizations can assist parents by emphasizing the importance of science education and the need for Black scientists in the community and in the world (Olden 1993).

In addition, it is important that parents provide a wide variety of age-appropriate reading material in the home. Children can be stimulated to read, and will learn the value of books if parents themselves read, and also read with and to their children. Many White

females have cited the importance of the early support of their parents in promoting self confidence and their interest in science and mathematics (Hafner 1993; Clewell & Anderson 1991). Schools may have to develop training programs to show parents how to assist their children to become better students. According to the U.S. Department of Education (1993), "Schools and parents need to encourage hard work, hold high expectations of students and push students to the outer limits of their potential."

In 1991, a research team at Columbia University began the *Project Synergy Summer Program* at Teachers College in an effort to identify potentially gifted kindergarten children from some of the public schools in Harlem. They were looking for children having "... longer-than-average attention, worked productively and showed creativity in storytelling, resolving conflicts and other areas . . ." (Celis 1993; United States Department of Education 1993). Based on the results of the study, 5% of the 100 children observed were excelling. These five children were enrolled in a school for the gifted. Professor James Borland of Teachers College concluded:

It tells us that there are gifted kids everywhere in the country, but because they are poor or African-American or Hispanic, they are being overlooked. . . . We didn't turn them into gifted kids, we looked and recognized their potential, and they have a much better chance now (Celis 1993).

Intermediate School

1. It is well documented that girls begin to lose interest in subjects described as the "male domain" as they move into junior high, and from there to high school. Competition between the genders becomes more intense during these transitions. It is necessary for teachers, most of whom are women (Rossiter 1982), to become aware of and to reduce gender or racial bias in the classroom (Sadker & Sadker 1994). They must maintain the same expectations of success in science and mathematics for girls as they do for boys.

While most teachers are women, Lindauer and Queitzsch (1996) have reported that 92% of the public school biology teachers of grades 7-12 in the United States are White, 5% are African-American, and 3% are other ethnicities. They have also determined that only 38% of the women teach biology in grades 9-12 compared to an equal distribution of men and women biology teachers in grades 7 and 8. Their data demonstrate the need for a more ethnically diverse science teacher population and the need for more women science teachers in grades 9-12.

2. Prospective science and mathematics teachers should graduate as science or mathematics majors, with the requisite educational training and credentials to become certified. These certified teachers would be less likely to convey fear, uncertainty, or dislike for these subjects, and could become the role models and

mentors for aspiring scientists or mathematicians (Massey 1992).

In 1992, City University of New York (CUNY) began a Workforce Development Initiative focusing initially on teacher education and the health sciences. Reports published in 1990 showed that in New York City, 60% of the newly hired teachers lacked certification. The shortage of teachers certified in science and mathematics was severe (Berkman 1994a). According to Dr. Robert Tobias, Director of the New York City Board of Education Office of Educational Research, 25% of middle school mathematics teachers are not fully certified. In some districts with large minority populations the number may be as high as 56% (Jones 1994a). The result of these inequities is a significant performance gap between White students compared to Black and Hispanic youth on the annual school-wide mathematics and reading exams. The former Chancellor of the New York City school system, Ramon Cortines, recommended strengthening curriculum, enhancing teacher training and improving instructional material. Middle schools needed special attention. Test data from middle schools show that scores in mathematics and reading drop when compared to those from elementary school. The data also indicated that boys began to out perform girls in mathematics and reading in the higher grades (Jones 1994a). Ogens (1991) cites equally dismal statistics for the nation as a whole.

Dr. Roscoe Brown, Director of the Center for Urban Education Policy at the Graduate School of CUNY, said, "In a sense these findings reflect social circumstances, the impact of racism and poverty. But they also reflect the fact that society has not provided adequate resources to address some of these concerns." On the same subject, Chancellor Cortines said, "We have to be very careful we don't blame the kids, saying 'he's poor, he's from a broken home.' We have to examine what happens in places of learning" (Jones 1994a).

Good teachers, properly certified in science and mathematics, may project more enthusiasm and interest. These competent teachers can help prevent the negativity that African-American high school girls develop toward these subjects, and, as role models, they could more easily recruit students to these fields.

High School

Studies have documented the obstacles African-American girls must overcome during this phase of their education (Clewell & Anderson 1991). Research also indicates that high school science and mathematics instruction should reinforce the self-confidence and interest African-American girls demonstrated in the earlier grades. To assist these young students, attention must be directed to critical areas important to their success as future scientists:

1. The academic experience of African-American high school girls can be enhanced by setting minimum standards for the number and content of science and mathematics courses required for high school graduation (Jones 1994b). In addition, all students will benefit from the improvement and expansion of high school science and mathematics curricula (Ogens 1991).

One model for curricular improvement is the College Preparatory Initiative (CPI). CUNY is now operating under a CPI program which is being phased in over 10 years. Under this plan, all students entering the University must complete four units in English; four units in Social Studies; three units in Mathematics; two units each in Foreign Language and Laboratory Sciences; and one unit in Visual or Performing Arts. The early results of CPI indicate that a larger number of New York City high school students are taking more mathematics, English and foreign language courses than they did before the implementation of CPI. Students are entering CUNY better prepared to succeed in college level courses (Berkman 1994b).

2. A study by the United States Department of Education (1993) cites the deficiencies in mathematics, history and science exhibited by American high school seniors. The data were based on the results of their National Assessment of Educational Progress (NAEP) examinations. International test data from 13 countries show that American high school students rank at or near the bottom in biology, chemistry and physics (U.S. Department of Education 1993).

The International Baccalaureate (IB) program addresses these deficiencies. One hundred and ninety high schools in the United States are participating in the IB program which is a "rigorous two-year regimen of advanced studies taken by more than 19,500 high school students in 71 countries" (Rose 1994). Schools with large minority and immigrant populations in Miami, Chicago, and Long Beach, California, are participating in this program. Students seeking an IB diploma must study world literature, a foreign language, mathematics, science, history/social studies, and an elective. Three of these subjects must be studied at a "high level" and others at a "subsidiary level." Students in the program prepare extended essays and term papers, take oral exams, and complete a community service requirement. Teacher training is a critical component of this program (Rose 1994).

The rigorous requirements of the IB degree program should be more widely implemented in American schools, particularly those that service poor, predominantly minority populations. African-American girls must be encouraged to enroll in these programs. These students represent an enormous pool of untapped talent. Yet it is too often assumed that children from unpromising backgrounds, many of whom are African-American, are incapable of outstanding accomplishments. Stories abound of disadvantaged children

who attain high achievement levels when nurtured and motivated (U.S. Department of Education 1993).

3. Textbooks must be rewritten to include the contributions of women, and African-American scientists and mathematicians. Science curricula must be pluralistic and reflect the contributions of all people. A pluralistic curriculum would sustain all students' interest and instill confidence and pride in all of them.

4. Too few African-American female students have the opportunity to see scientists at work. Therefore, they have inaccurate ideas of what it takes to become a scientist, what scientists do, or even the value of science in their lives (Olden 1993). If the quantitative sciences are to become the careers of choice, African-American female students must have more opportunities to interact with professionals in these fields. In addition, they need opportunities to undertake scientific research, collaborating with experienced research advisers, preferably African-American or other minority women. These experiences give students the opportunities to determine if they want to become career scientists. They may also alter the stereotypical perceptions of scientists shared by so many youngsters.

5. All outstanding students, particularly African-American females, must be recognized, rewarded and encouraged to continue their academic development. Although there are programs for high-achievers at the high school level in most states, some minorities are often overlooked and discriminated against. In 1989, in Rockland, Illinois, a multiracial parents' group sued the school district. They charged that the district discriminated against bright Black and Hispanic students by excluding them from classes for high achievers, even when their scores were higher than those of the White students who were already in these classes. The judge who heard the case concurred with the parents and found this exclusion to be a fundamental violation of the desegregation laws enacted as a result of *Brown v. the Board of Education of Topeka, Kansas*. The judge wrote that the school district had systematically "committed such open acts of discrimination as to be cruel, and committed others with such subtlety as to raise discrimination to an art form" (Celis 1993). This school district, and others, were forced to begin to examine whether tracking, a method of assigning students to classes based on ability, was either equitable or beneficial to any students, regardless of the track in which they were placed.

With so much emphasis on remediation in schools (generally believed to be needed only by minorities), gifted students are often overlooked and unchallenged. The U.S. Department of Education reports:

Most top students in the United States are offered a less rigorous curriculum, read fewer demanding books, complete less homework, and enter the workforce or postsecondary education less well prepared than top students in many other industrialized countries. These deficiencies are particularly

apparent in the areas of mathematics and science (U.S. Department of Education 1993).

This same report faults the use of IQ tests and IQ test cutoff scores to identify the gifted students. According to the report, these test results have been used as justification for the neglect of the poor, minority, disabled, female, artistic, and high potential under-achieving students, who are gifted in other ways, undetected by these tests. The report also states that psychologists and neuroscientists agree that general intelligence and a good school record are not the only criteria for measuring intelligence.

6. African-American female students must be made to feel secure in their pursuit of academic excellence by counselors, teachers, parents, and other significant people in their lives. Historically, counselors directed White females and, undoubtedly, Black females as well, away from the "male fields" of science and mathematics (Rossiter 1982; Fins 1979; Cole 1986). African-American female students having both the aptitude and interest in the quantitative sciences must be encouraged to pursue studies in these areas. To many African-American young people, science and mathematics are subjects that White students study. Black students do not want to be accused of "acting White" by their peers and of identifying too closely with the White students. Parents and counselors must dissuade the Black students from this idea. When a larger number of African-American school children begin to take these courses, perhaps more will be willing to enroll in them.

Parents have indicated the importance of taking an active role in the education of their children. Dr. Rita Colwell, a bacteriology professor at Purdue University, commented about her "good looking" daughter who was told by a teacher that she need not be good at everything, especially not mathematics. Dr. Colwell stated:

This specific incident is typical of the socialization of high school girls away from math. . . . The directing of women away from math is the primary cause of young women not entering science careers (Fins 1979).

Gregory Anrig, President of the Educational Testing Service, explains the situation that bright students may have to face:

In America we often make fun of our brightest students, giving them such derogatory names as nerd, dweeb, or, in a former day, egghead. We have conflicting feelings about people who are smart, and we give conflicting signals to our children about how hard they should work to be smart. As a culture we seem to value beauty and brawn more than brains (U.S. Department of Education 1993).

7. Poor career counseling, educational deficiencies and lack of role models have limited the career goals and career options for African-American high school students (Massey 1992). Counselors can help them

match their career goals with their abilities and interests. However, counselors and teachers must recognize that the aspirations of some of these students may be limited due to lack of exposure at an early age to cultural and social activities available to students from more affluent families and school districts. Many African-American children living in the inner cities rarely leave their neighborhoods or have a safe place to pursue productive extracurricular activities which interest them. These kinds of environmental deficiencies do not produce well-rounded individuals with wide-ranging general knowledge.

Special programs designed to increase the number of African-American females studying the quantitative sciences should be directed to correcting these deficiencies. These programs should: a) emphasize reading, writing, reasoning, and computer skills; b) expose students to extra-curricular opportunities as discussed for the elementary school student. School counselors and teachers must encourage African-American high school girls to participate in these science-related activities. As a result of these directed efforts, African-American female students should experience greater self-confidence, expanded knowledge of the quantitative sciences, and should, therefore, be able to make informed career choices.

Higher Education

Completion of a four-year degree in science and mathematics has not always been an option for African-Americans. A disproportionate number are directed to community colleges where they receive a terminal degree and then enter the work force (Cole 1986). Without an advanced degree and training, there is little possibility of a high level career in science or mathematics. In order to assure that more Black females receive advanced degrees in the quantitative sciences, some consideration should be given to the following areas:

1. Good career counseling for college students is a necessity, but according to Moss (1994), it is not always available. As a consequence, many students, not recognizing their own abilities, interests and talents, choose inappropriate majors, do not succeed, and end up dropping out of college. Proper career counseling and academic advisement is needed to keep Black female students in college and to guide those who are interested and qualified to take advanced courses in science and mathematics. Success in these courses in undergraduate school could lead to an advanced degree and a career in the quantitative sciences.

2. Scholars indicate that the freshman year is the critical period for prospective female scientists. It is during this time that more females than males leave science programs (Marks 1994). Recognizing the need

to encourage African-American females to enter and persist in the study of the quantitative sciences, the federal government, together with universities, colleges and some private foundations, have sponsored special programs at, for example: Spelman College, for science and engineering, and East Carolina University for engineering. In the five-week prefreshman program in mathematics and science at Georgia Tech, the emphasis is on positive reinforcement instead of remediation (Smothers 1994). A National Institute on Science, Space and Technology was established at Howard University to "increase the awareness of science, engineering and technology in the minority community," according to faculty member, Melvin Thompson (O'Brien 1987).

More than 10 years ago, Professor Uri Treisman started a mathematics workshop at the University of California at Berkeley to enable freshman science, mathematics and engineering majors to pass the first-year calculus class. The workshop class, composed of both White and minority students, meets several times a week to solve problems more difficult than those which the students get in their regular class. An African-American or Hispanic teaching assistant usually leads the class. The focus is on high achievement and academic excellence rather than remediation.

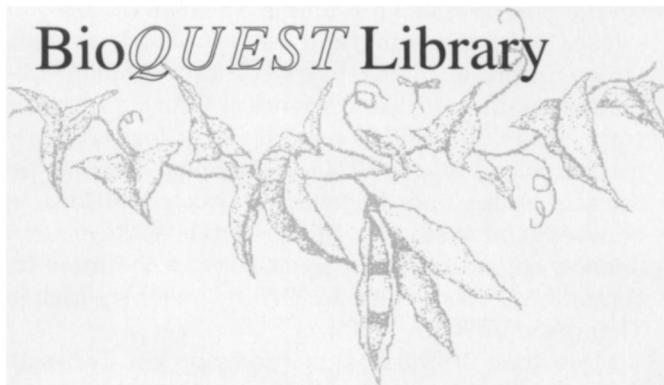
Pilot programs of a similar nature were begun at City College of CUNY, the University of Illinois at Urbana-Champaign, and at the University of Texas at Austin (Watkins 1989). It is important to determine the long-term effectiveness of these programs in increasing the success of African-American females and other minorities who choose careers in the quantitative sciences. If any of them are found to be effective, they should be expanded and used as models for other institutions to follow.

3. These programs must establish partnerships with the local school system at every level—high school, intermediate and grammar school. A "feeder school" system could ensure that African-American girls learn, during their early school years, that higher education, culminating in careers in science or mathematics, is a real possibility for them.

4. Cooperative learning, study groups, tutoring and counseling must be emphasized at all levels of education. My own observations of the benefits of study groups are that students who participate in them exhibit more improvement than those who do not have those cooperative experiences.

5. In addition to the above suggestions, students who excel deserve recognition and rewards. African-American women scientists and mathematicians should receive incentives to teach these subjects. For example, forgive educational loans in lieu of a specified period of service; or award scholarships to qualified women who choose teaching careers in the quantitative sciences. As science and mathematics

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teachers, Black women would be in positions to improve curricula and to design innovative learning strategies for African-American females, as well as for all female students (Mayhew & Muzio 1989; Fausto-Sterling 1981). These teachers would also fulfill the well-documented need for role models at all levels of the education of African-American students (Clewell & Anderson 1991; McBay 1992).

With the success of African-American and other women, as a result of the implementation of the programs discussed and the other recommendations proposed here, a concomitant change should develop in the prevalent male attitude that women have no place in science or mathematics. As a consequence, the resistance to, and discrimination against, women in these professions may decrease. The long-term effects of successful programs will be the infusion of new ideas and new approaches, and a rich and diverse expansion of the professions of science and mathematics.

Our country can ill afford to confront the 21st Century global economic village with a huge pool of underdeveloped human resources in the quantitative sciences. Improving the science and mathematics education of African-American female students at every level of study, and increasing the visibility and recognition of women scientists and mathematicians should encourage more African-American women to choose these careers. The United States and the world will benefit from the inclusion of more women scientists in decision-making processes. These fields may never be the same, and from an intellectual perspective, they could be remarkably different.

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